Anatomy of a Work Truck

Understand the Terms, Lingo and Processes Used by OEMs, Upfitters and Fleets

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THE ASSOCIATION FOR THE WORK TRUCK INDUSTRY

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ABOUT THE NTEA

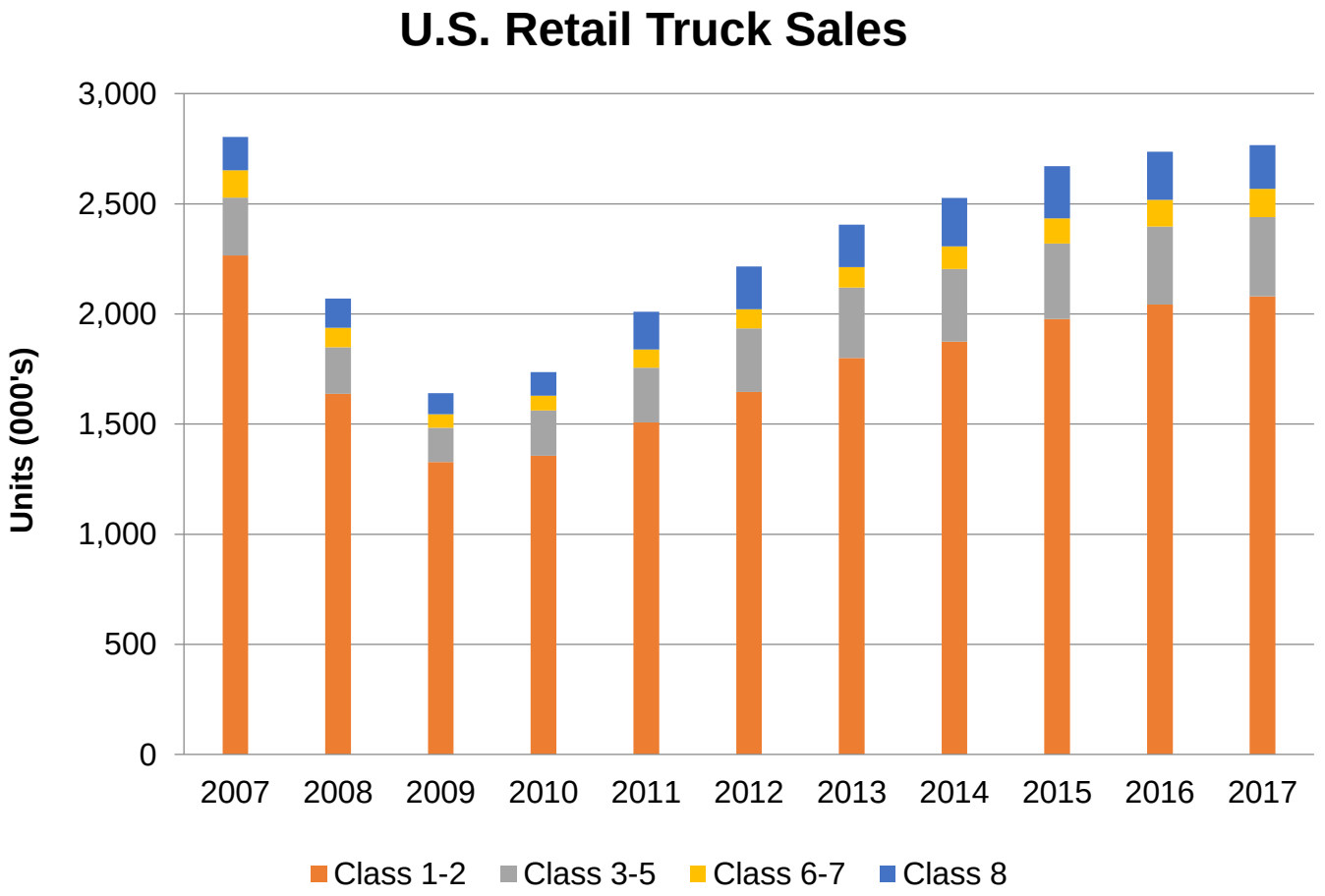
Established in 1964, NTEA, the Association for the Work Truck Industry, represents approximately1,600 companies that manufacture, distribute, install, sell and repair commercial trucks, truck bodies, truck equipment, trailers and accessories. Buyers of work trucks and the major commercial truck chassis manufacturers also belong to the Association. The NTEA provides in-depth technical information, education and member programs and services, and produces The Work Truck Show®. The Association maintains its headquarters in suburban Detroit and a government relations office in Washington, DC. For more information, call 1-800-441-6832 or visit www.ntea.com.

About the Green Truck Association

The GTA is an affiliate division of the NTEA. Its mission is to improve the efficiency and productivity of work trucks through the development and deployment of strategies to reduce diesel and gasoline consumption and the associated environmental impacts. To learn more, visit www.greentruckassociation.com.

Class 1-8 U.S. Retail Sales

Strong Ongoing Market



Complexities of the Supply Chain

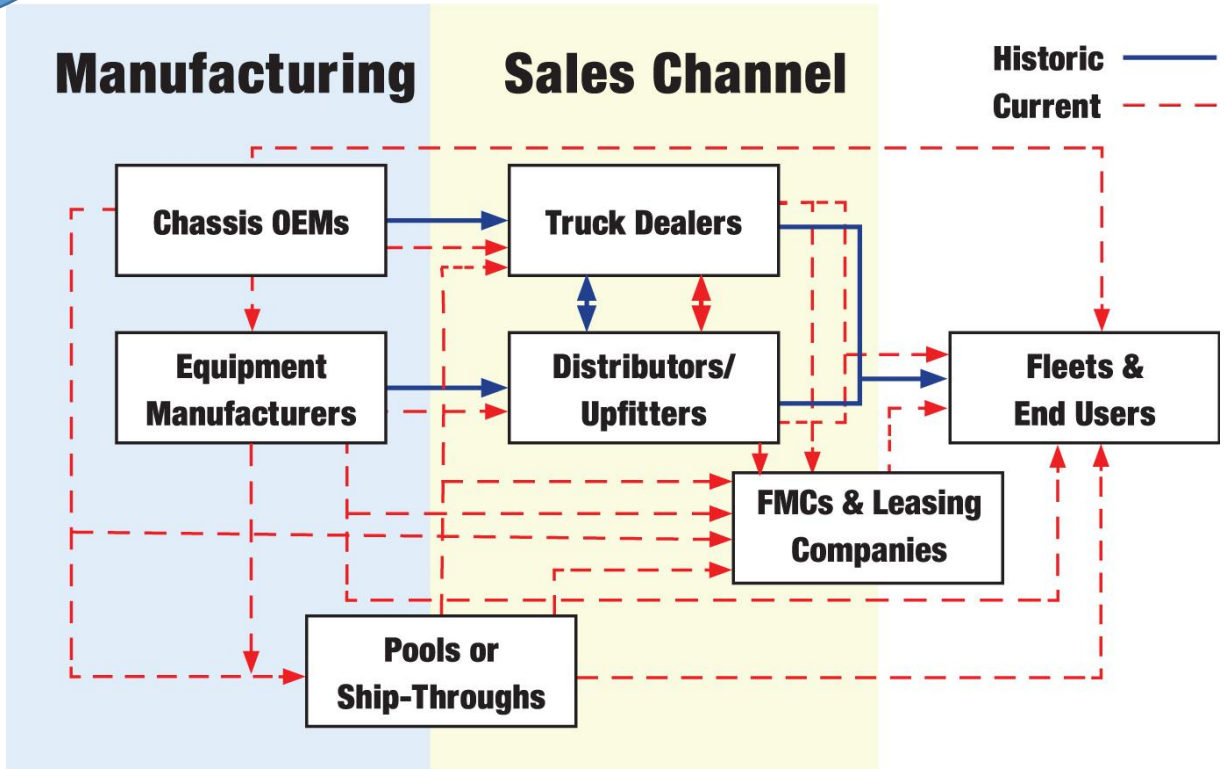
State & Local Funding and Tax Incentives

Federal Government Funding and Tax Incentives

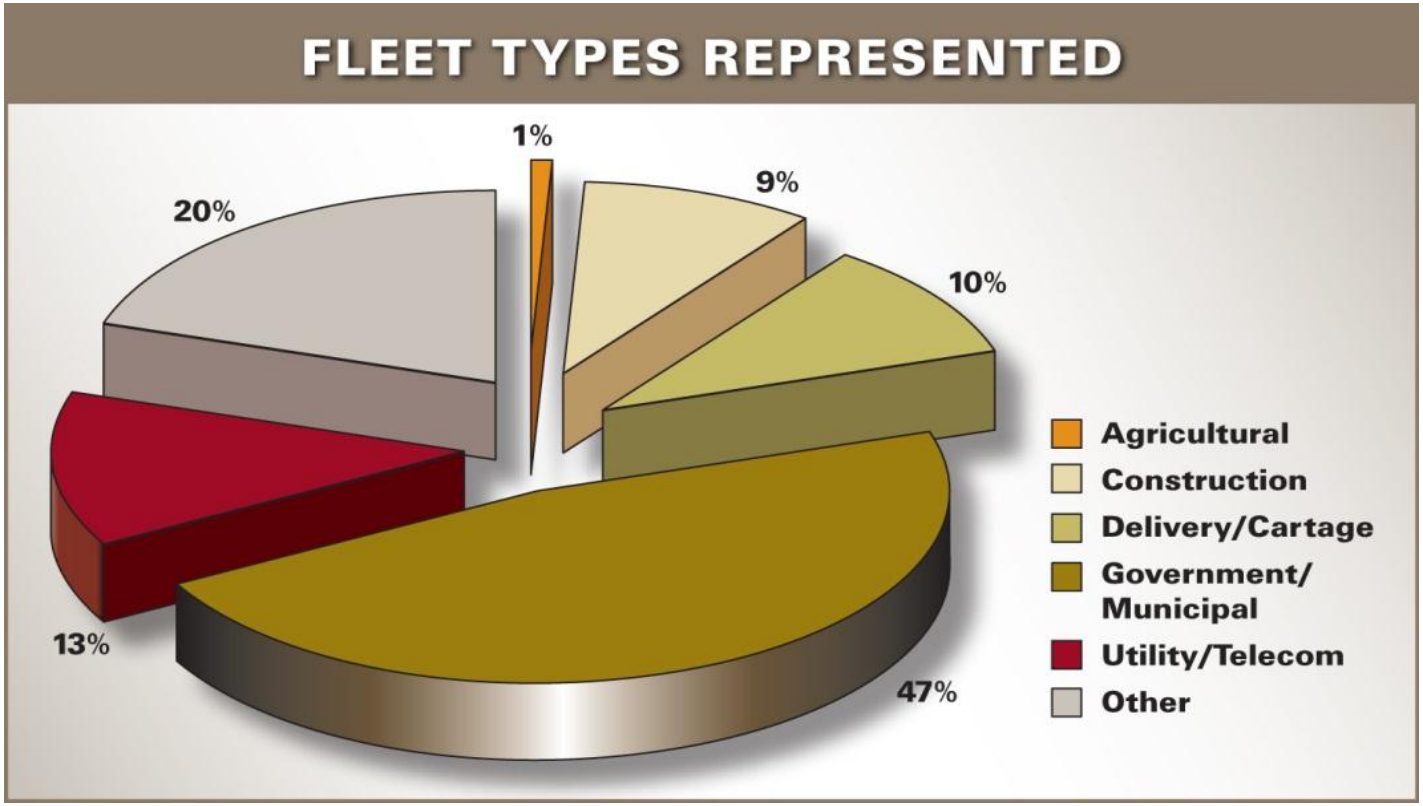
Clean Cities, Associations, Others

Green Tech Suppliers

Truck Equipment Industry value chain …



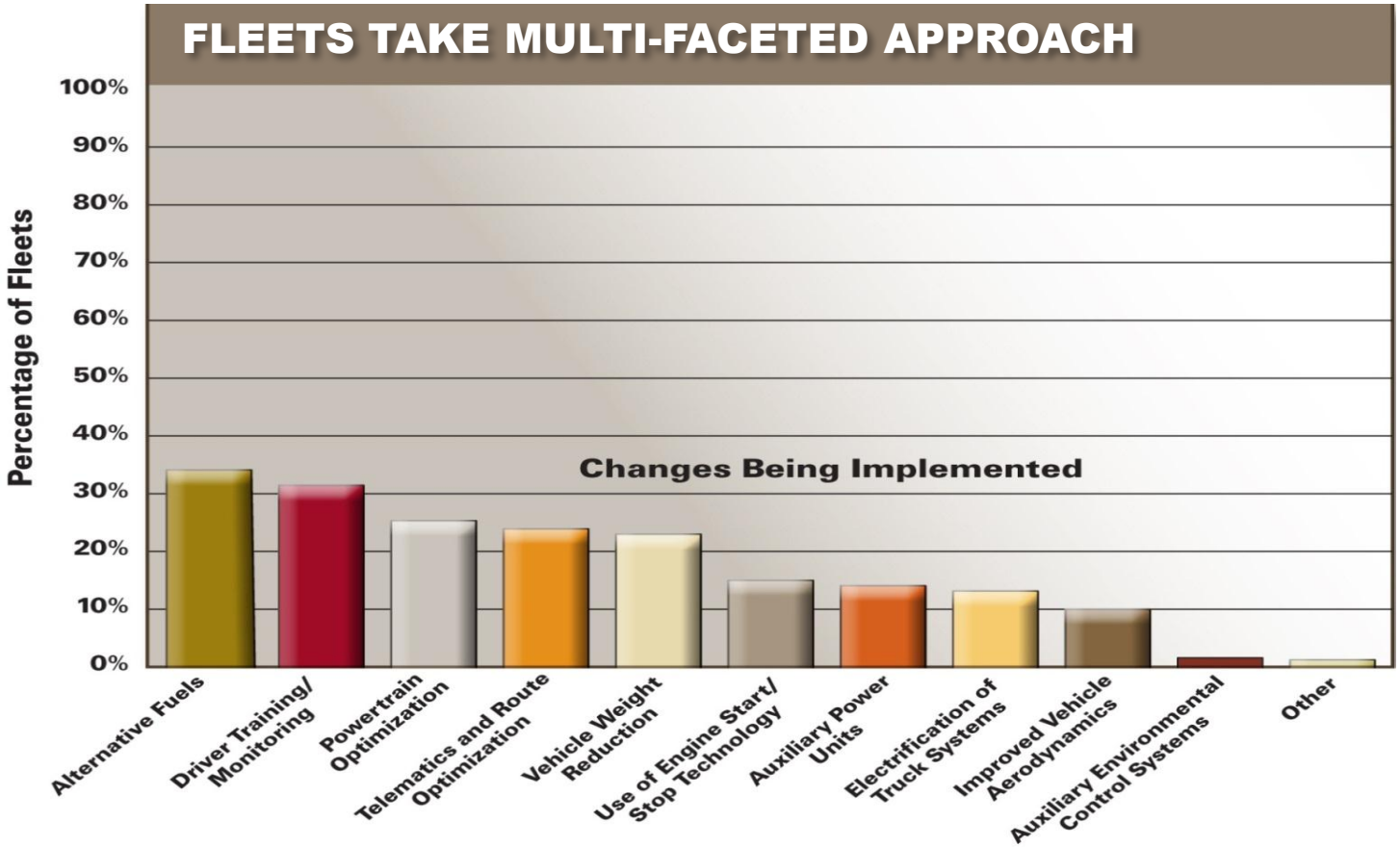
Vocational Demographics



287 Fleet Respondents

Source: *2013 NTEA Fleet Purchasing Outlook*

Fuel-saving Strategies



Source: ***2013 NTEA Fleet Purchasing Survey***

OEM Perspective

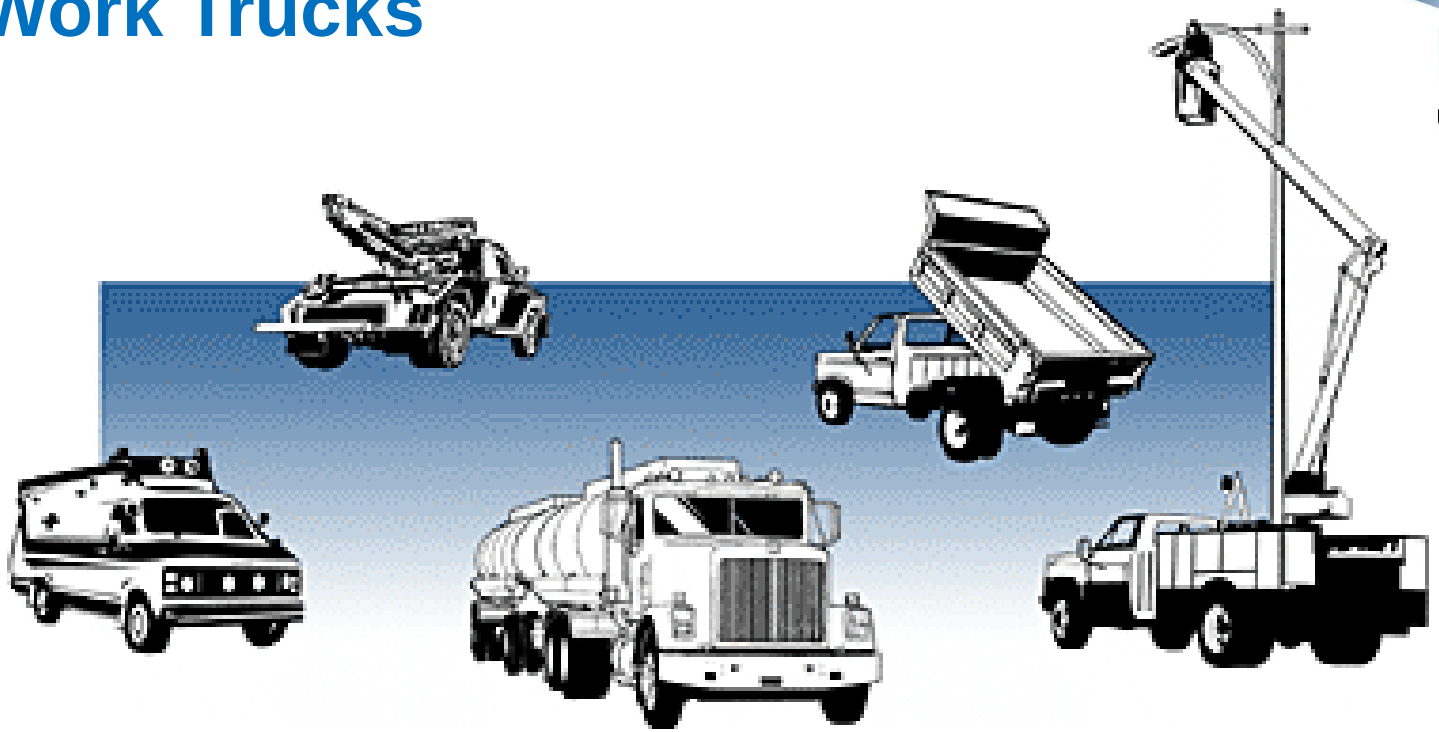
- CNG is a prime focus
- An order of magnitude breakthrough is needed for electric hybrid and/or electric drive
- Diesel will be with us for a very long time and we can expect breakthroughs in this engine technology
- Fleets / users see life-cycle cost as the prime acquisition criterion

ANATOMY OF A WORK TRUCK

Understanding the terms and lingo used by OEMs and Fleets

America's truck population is estimated to be more than 90 million vehicles with 4 million being vocational vehicles. Employing more than 175,000 Americans, the truck body and equipment industry produces $15 billion+ in annual sales. Adding chassis manufacturers to this already-substantial figure creates a total market of $67 billion. Although these figures represent only a small percentage of the multibillion-dollar transportation industry, our country's economy and productivity depend largely on this highly specialized trade.

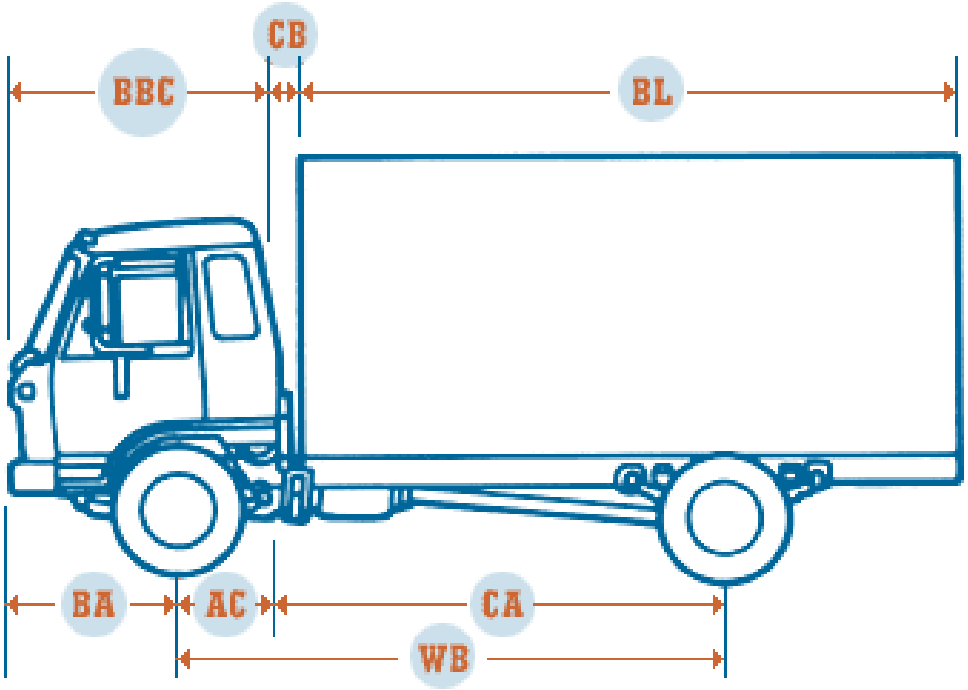
Work Trucks



Unlike mass-produced assembly-line passenger cars and trucks, commercial vehicles are primarily designed and produced individually, on a custom-order basis. Their diverse applications, limited volume, and nearly limitless body and equipment variations dictate this method of production.

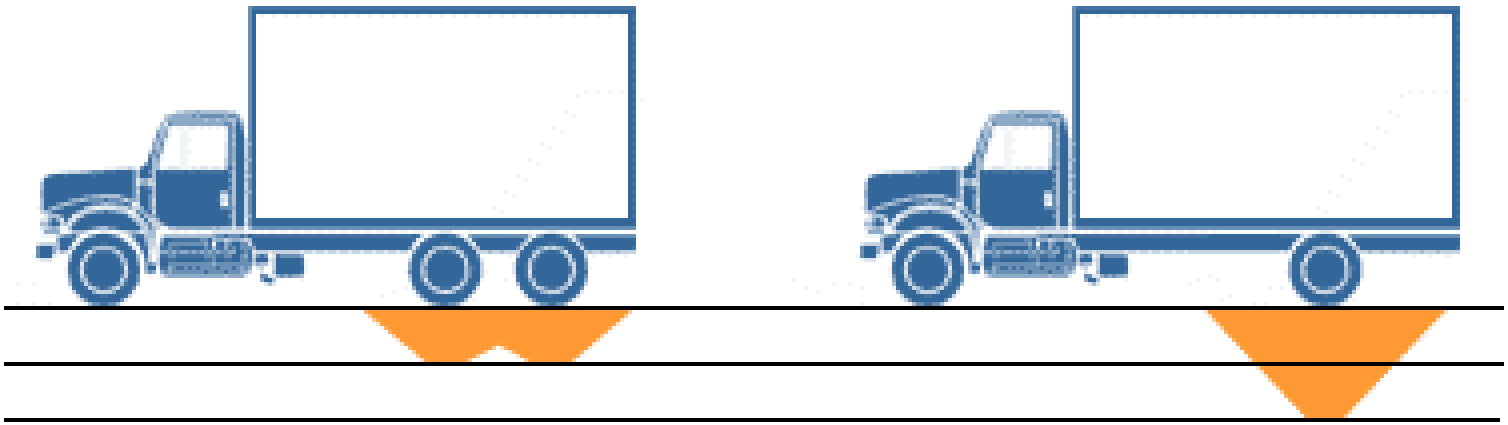
Where a Work Truck Starts

Each commercial vehicle originates at the assembly plant of one of the world's truck/truck chassis manufacturers. Approximately 15 companies produce light- and medium-duty trucks, truck chassis, and cab-chassis (basically, a cab, frame and drive -train) suitable for completion as commercial vehicles. Through truck dealerships, these products are supplied to truck body and equipment firms for final assembly and installation before delivery to the customer or end-user.



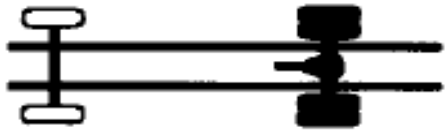
WB = Chassis Wheel Base
CA/CT = Cab to Axle/or Cab to Center of Tandem
CB = Cab to Body Clearance
AC = Front Axle to Back of Cab (WB - CA = AC)
or (BBC - BA = AC)
BA = Front Bumper to Front Axle
BBC = Front Bumper to Back of Cab
BL = Body Length

Carrying Loads

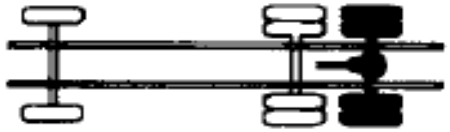


CW = Chassis Curb Weight
CWR = Chassis Curb Weight - Rear
GAWR.F = Gross Axle Weight Rating - Front
GAWR.R = Gross Axle Weight Rating - Rear
GVWR = Chassis Gross Vehicle Weight Rating

There are also many truck axle-drive combinations to meet different hauling and terrain conditions. The following drawings illustrate the most common ones and their accepted names. *Shaded wheels and axles are the driving units.* Dual tires are considered as one driving wheel.



4x2 – 4 wheels, 2 driven
1 driving axle



6x2 – 6 wheels, 2 driven
1 driving axle with pusher axle

4x4 – 4 wheels, 4 driven
2 driving axles

6x4 – 6 wheels, 4 driven
2 driving axles

6x2 – 6 wheels, 2 driven
1 driving axle with tag axle

6x6 – 6 wheels, 6 driven
3 driving axles

Adding Axles

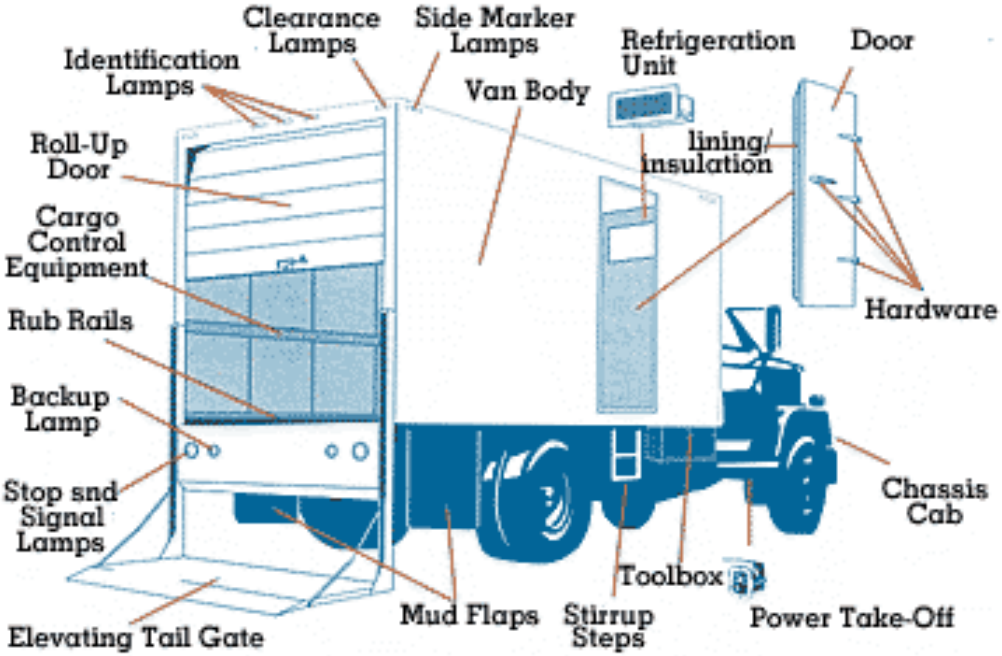
The dead axle is installed either ahead of the live axle or behind it, depending on the truck and the operation. When installed behind the live axle it is called a *tag axle. When installed in front of* the driving axle it is called a *pusher axle.*

Common Components

Components of commercial vehicles range from tiny gears and parts to larger products such as cranes, snowplows and liftgates. Here are some common truck equipment and accessories:

Aerial Devices
Alarms
Brake Components
Bumpers
Cabs
Cargo Control Equipment
Cranes
Drive-line Components
Fifth Wheels
Fuel Tanks
Hardware
Hitches
Hoists
Hydraulic Components
Lift Axles
Lift Gates/Platforms
Lights
Power Take-Offs (PTOs)
Pumps
Racks
Ramps
Refrigeration Systems
Refuse Equipment
Shelving/Bins
Snowplows
Toolboxes
Winches

Making a Chassis a Work truck



Depending on its application, a commercial truck can require a few basic pieces of equipment (such as a snowplow or a stake body) or a wide variety of components. It is the distributor's role to combine and install all of these components, supplied by their various manufacturers, to complete the truck for its specific use.

Green Fleet & Truck Efforts

DESIGN AND ENGINEERING OF A WORK TRUCK

Motor Vehicle Certification

Understanding Multi-Stage Vehicle Certification and Labeling Requirements

Certify to What?

Certify that the motor vehicle conforms to all applicable Federal Motor Vehicle Safety Standards (FMVSSs).

- 49 CFR Part 571 - FMVSS
- 61 FMVSS
- 48 FMVSS applicable to “Trucks”

Law & Regulations

Law: Title 49, United States Code Section 30115 – Certification of Compliance

National Highway Traffic Safety Administration (NHTSA) Regulations:

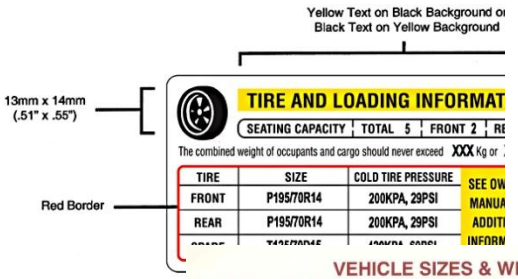
- 49 CFR Part 567-Certification
- 49 CFR Part 568-Vehicle manufactured in two or more stages

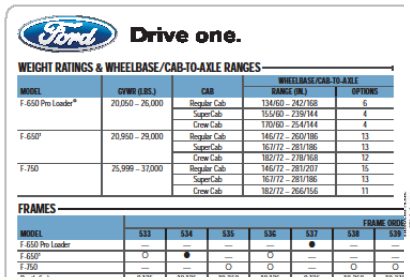
Who is Required to Certify?

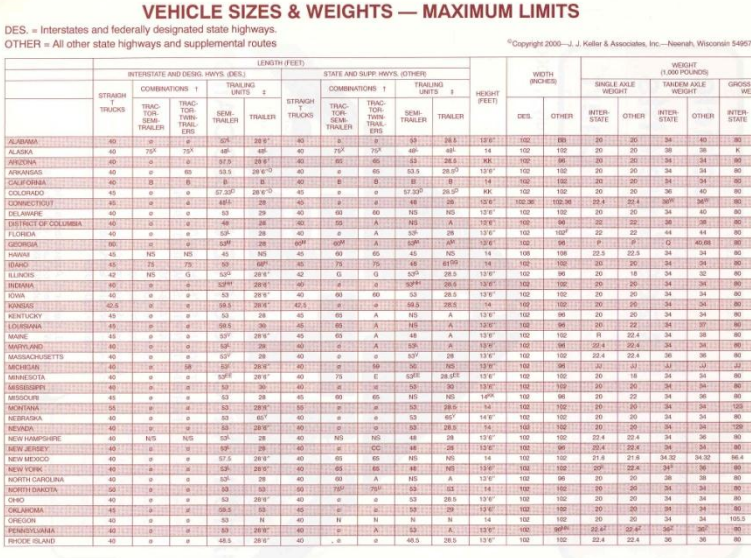
Final stage manufacturers, intermediate manufacturers and alterer of motor vehicles and motor vehicle equipment

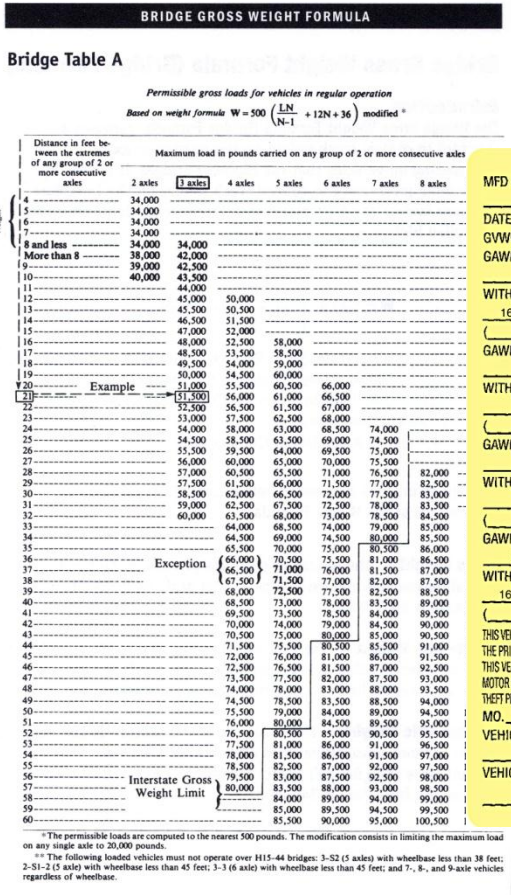
It is about the work system, not the just the truck!

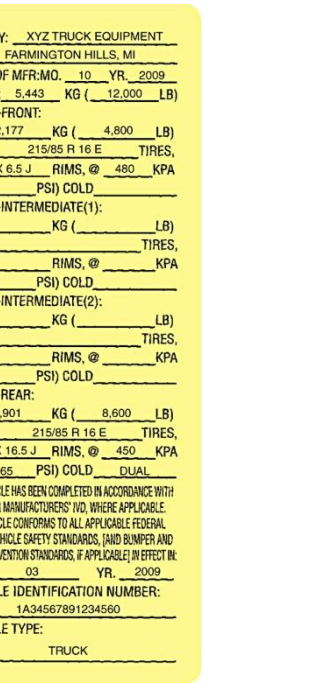
What and Why of Weight Distribution











WHY? For compliance with:

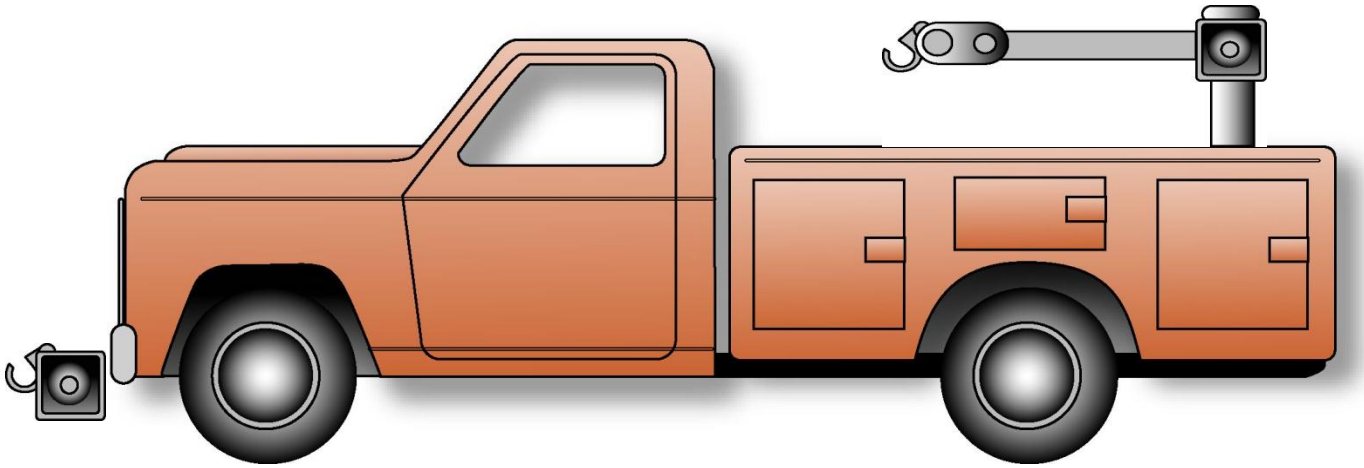
- **Wheel/tire capacities**
- **Axle capacities – GAWRs**
- **Vehicle capacity – GVWR**
- **State weight laws**
- **Federal weight laws**
- **FMVSS**

CRITICAL ELEMENTS OF CERTIFICATION

Payload analysis
Weight Distribution
FMVSS Compliance Analysis
Drive and Duty Cycle

Payload Analysis

Maximum Net Payload Analysis



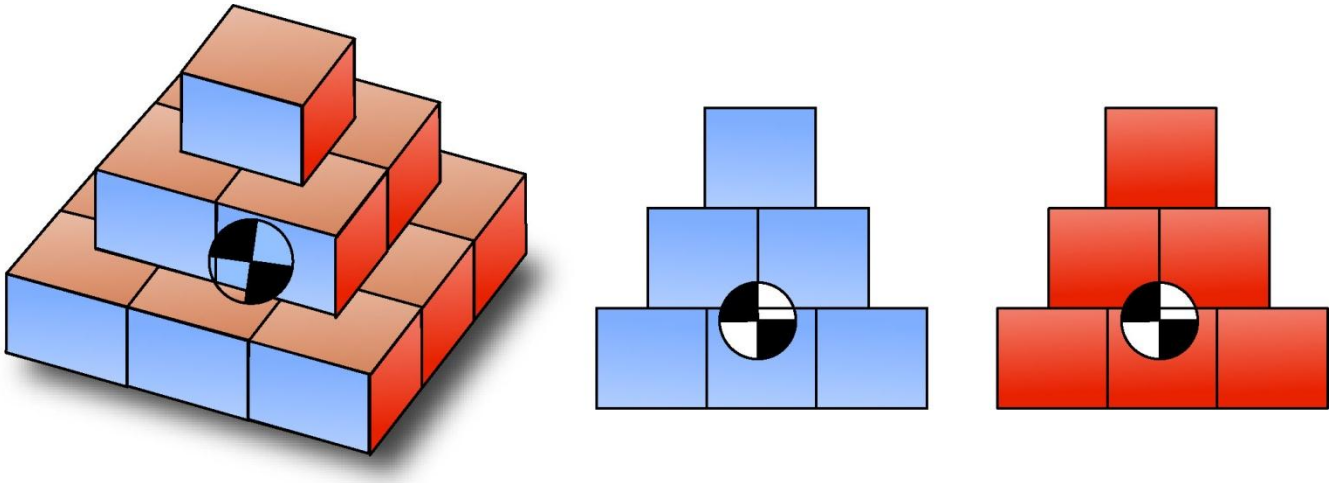
Component	Weight
Chassis	5,906 lbs / GVWR 9,800 lbs
Body	1,355 lbs
Winch	150 lbs
Crane	630 lbs
Cargo	1,300 lbs (Customer Requested)
Passengers	450 lbs

Space
Weight
Safety
Vertical CG

Basic Principles

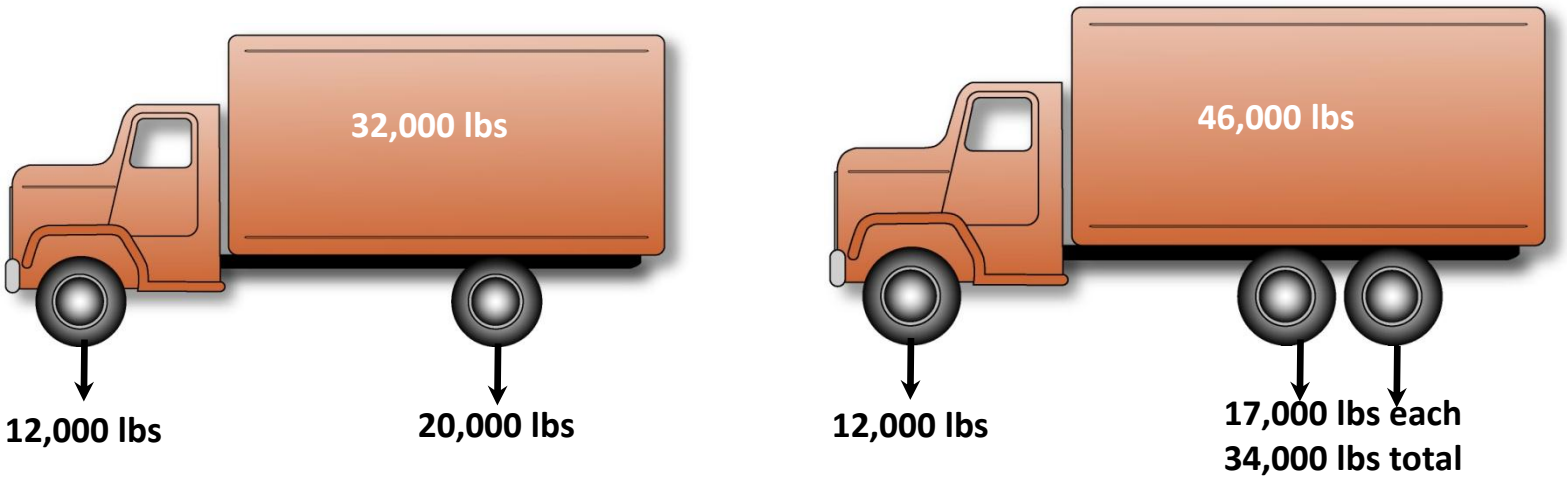
Combined Center of Gravity

When a group of objects are combined they have a combined Center of Gravity.



3D View | Front View | Side View

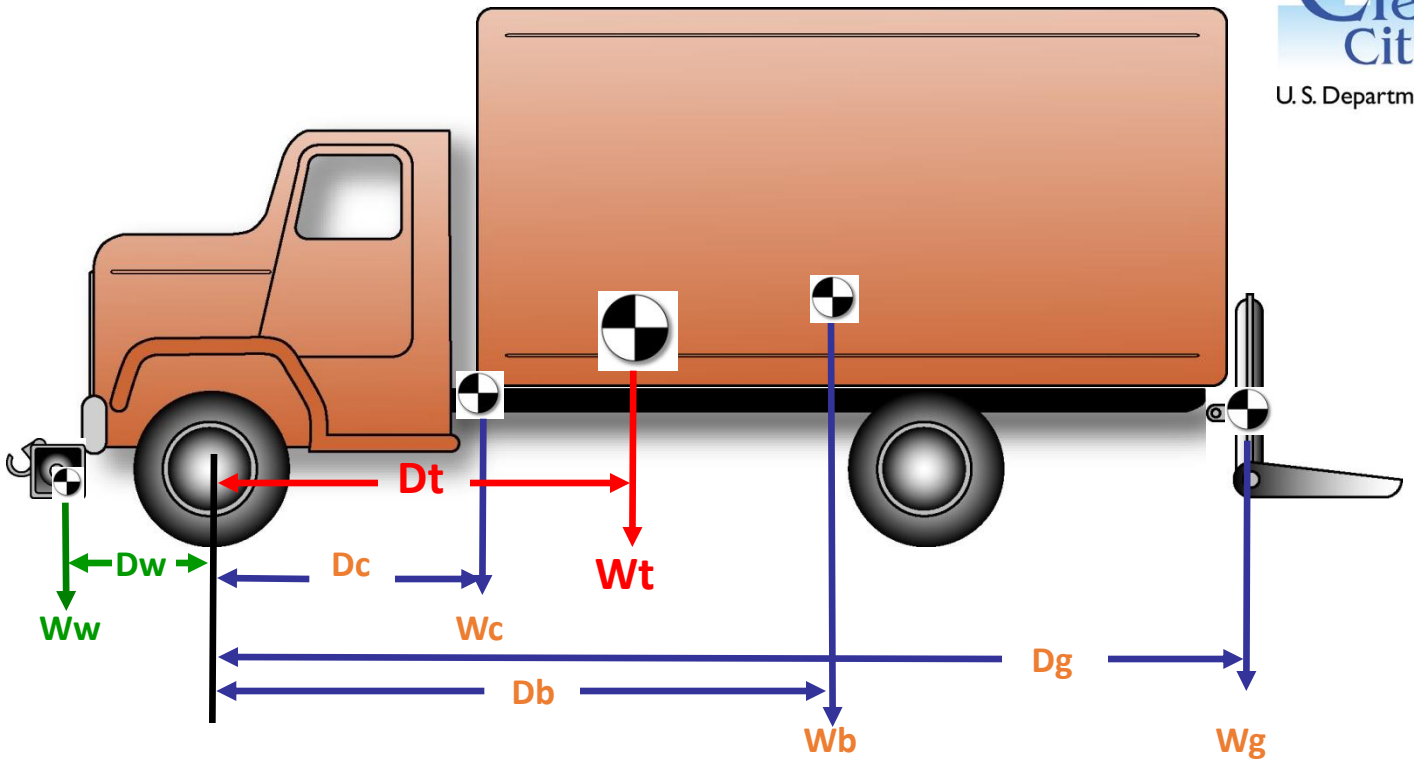
What and Why of Weight Distribution



WHAT – weight distribution is the amount of the total vehicle weight imposed on the ground at an axle, group of axles, or an individual wheel. The weight on a truck must be distributed on the axles to comply with the chassis manufacturer's axle ratings and the weight laws.

In the examples above, having the correct wheelbase on the chassis and placing the bodies and loads in the proper place will assure that the axles are loaded correctly. Doing a weight distribution will tell us that we can achieve the proper axle loadings before building the truck.

Center of Gravity



Moments give us a way to combine a number of components or items to calculate a center-of-gravity for them as a group. When we know the center-of-gravity distance for all of the items combined, we can calculate the weight on each axle.

$$Dt = \frac{Dc*Wc + Db*Wb - Dw*Ww + Dg*Wg}{Wc + Wb + Ww + Wg}$$

(Total Moment)

(Total Weight = Wt)

Weight Distribution

- Perform weight distribution using maximum net payload to determine if GAWRs are exceeded. If so, reduce payload accordingly and revise payload analysis.
- Both payload analysis and weight distribution need to be kept as part of certification documentation.

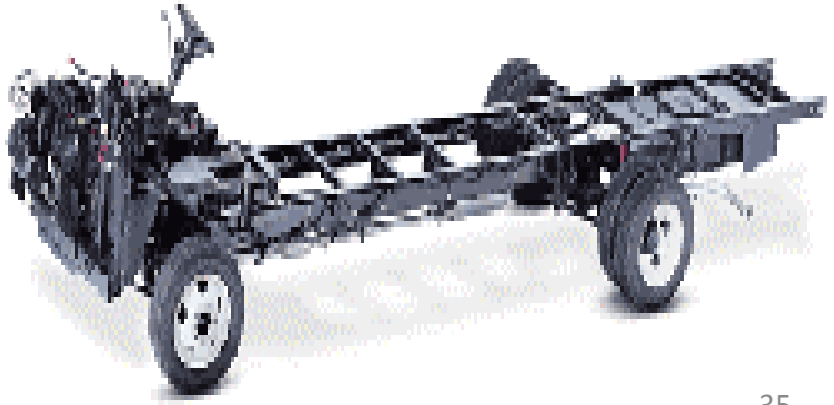
Vehicles 10,000 lbs GVWR and Under

Some example restrictions due to barrier test requirements:

- Maximum vertical Center-of-Gravity for the body
- Maximum added equipment weight
- Curb weight of the finished vehicle
- Minimum cab-to-body clearance

Final Stage Certification Label

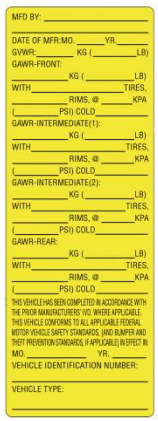
For Chassis Cabs, Cutaways, Chassis Cowls and Strip Chassis



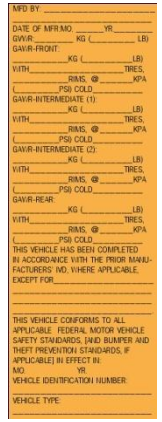
Final Stage Certification Label

For Chassis Cabs, Cutaways, Chassis Cowls and Strip Chassis Over 10,000 lbs

+



or



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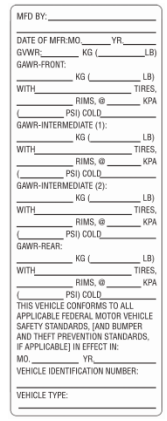

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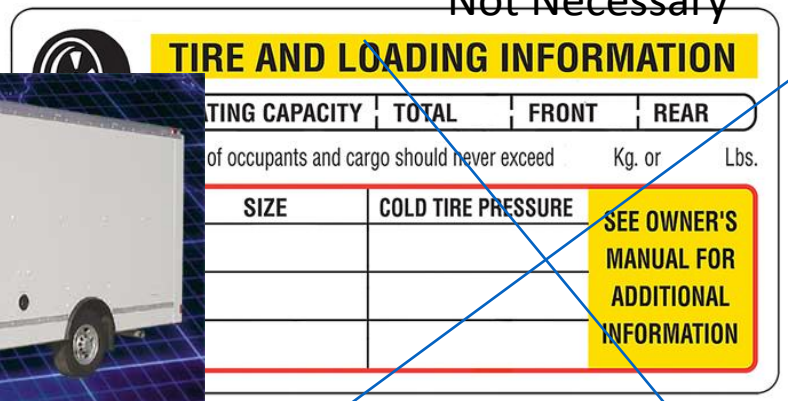
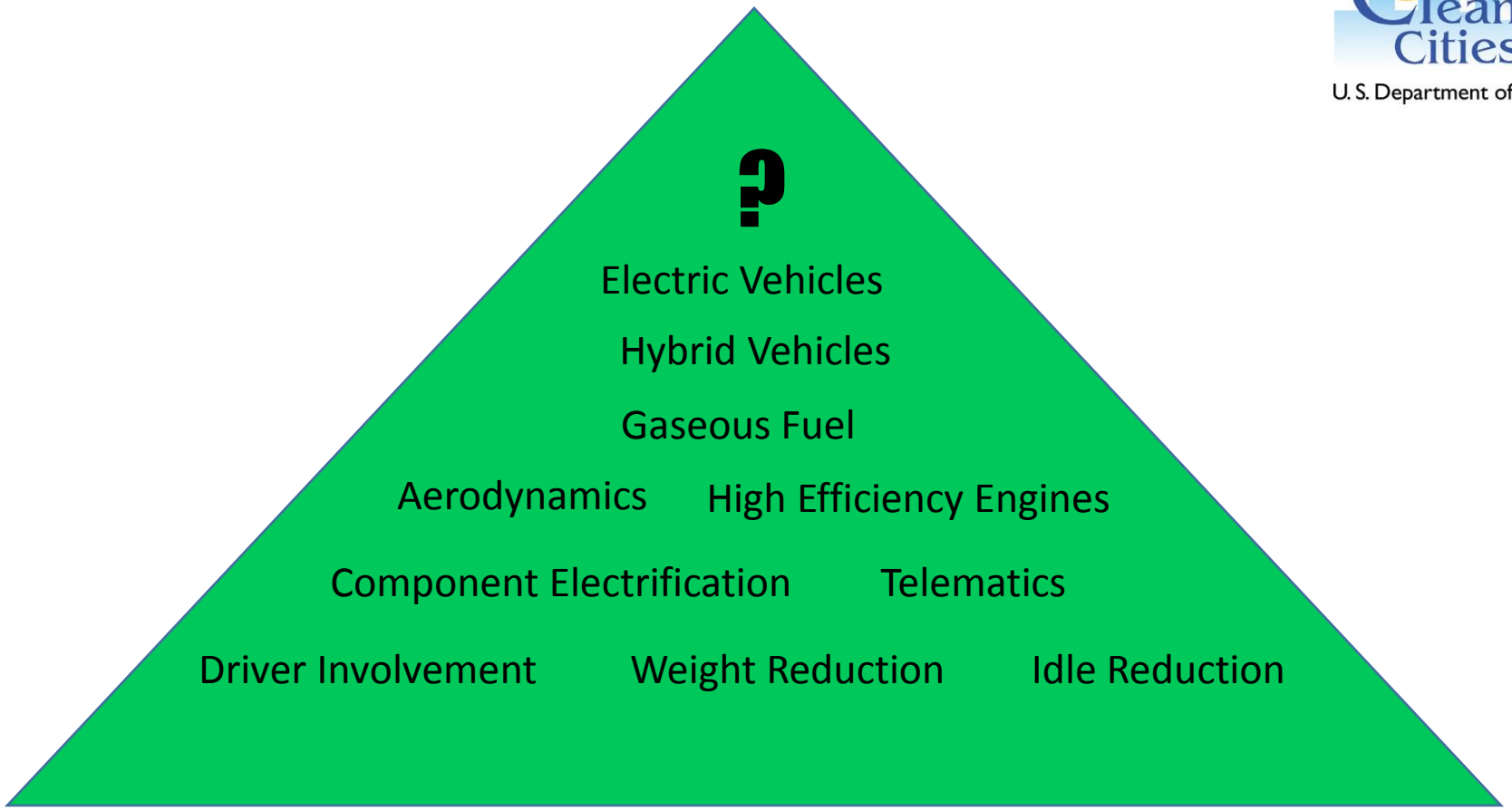
Not Necessary

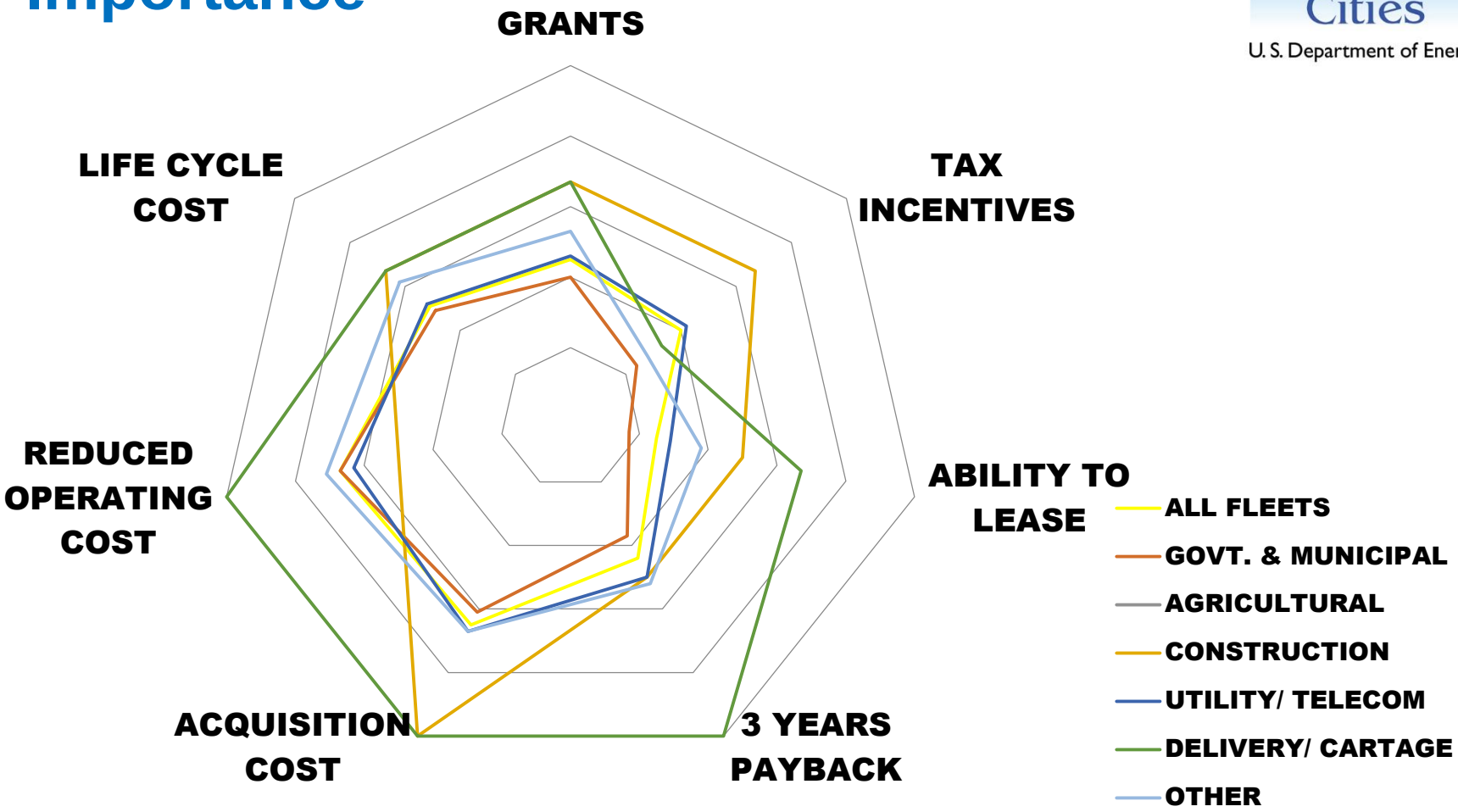


Hierarchy of Application



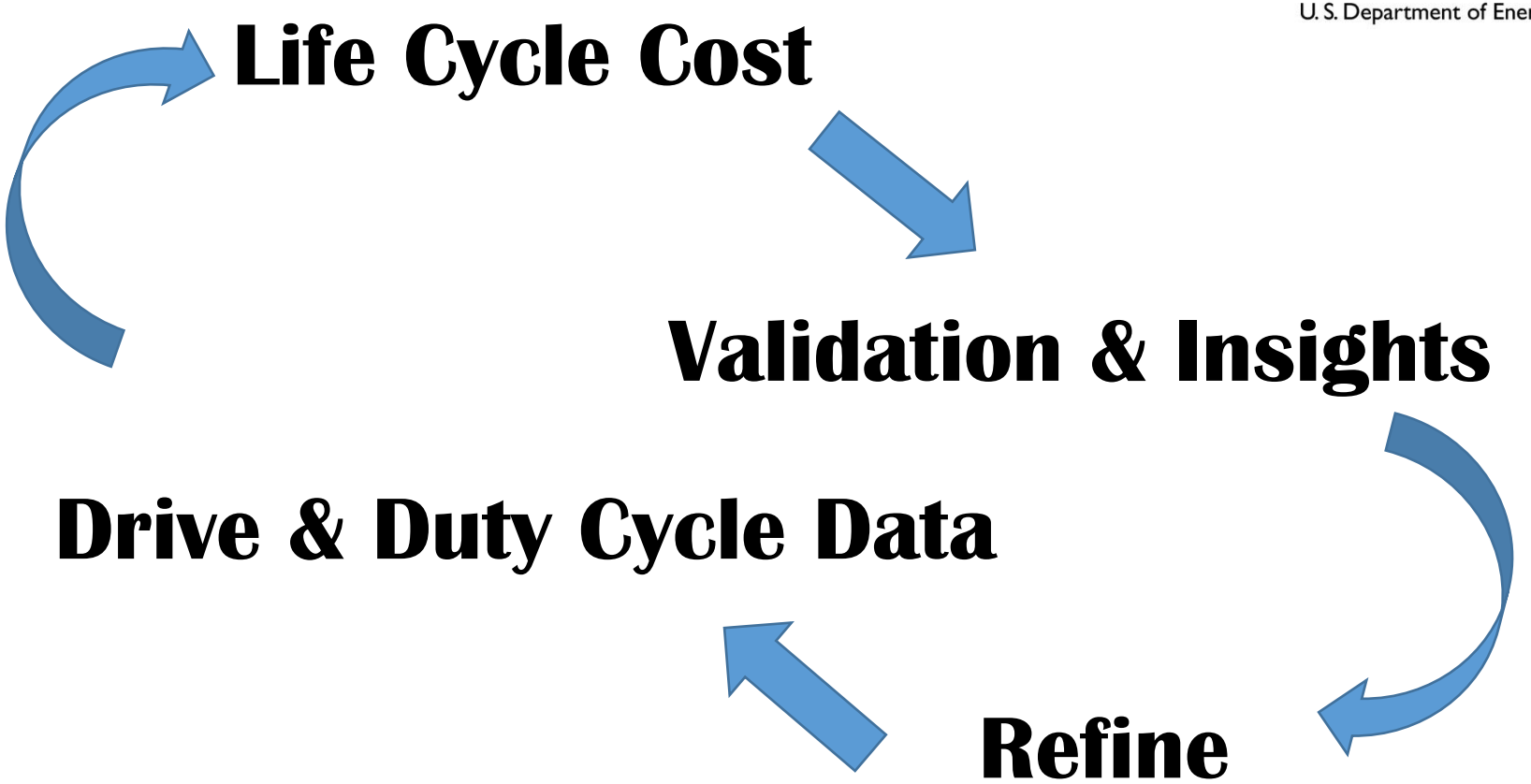
Pyramid of Solutions

% of Fleets See Factor as High Importance



Source: *2013 NTEA Fleet Purchasing Outlook*
(Acquiring fleets)

Using Analysis and Tools to Understand Payback



- **UNDERSTANDING USE & NEEDS**
- **COMPARING TECHNOLOGY & FUELS**
- **DEVELOPING BUY-IN**
- **REFINING RESULTS**

Using Analysis and Tools to Understand Payback

Drive and Duty Cycle Data

Validation and Insights

Green Fleet Tool

Simple Payback Calculator

	Gasoline	Diesel	Gasoline HEV	Gasoline PHEV 10-20	EV	Diesel HEV	Diesel Hydraulic Hybrid	Biodiesel (B20)	Biodiesel (B100)	Ethanol (E85)	Propane (LPG)	Compressed Natural Gas (CNG)	Liquefied Natural Gas (LNG)	LNG / Diesel Pilot Ignition
Light Duty Vehicle Infor														
Vehicle Type	Passenger Car													
Number of LDVs	0	0	0	0	0			0	0	0	0	0		
Annual Mileage	11,900	11,900	11,900	11,900	11,900			11,900	11,900	11,900	11,900	11,900		
Fuel Economy (MPGGE)	27.2	32.6	38.1	38.1	95.2			32.6	32.6	27.2	27.2	27.2		
Fuel Consumption (GGE/100m	3.7	3.1	2.6	2.6	1.1	0.0	0.0	3.1	3.1	3.7	3.7	3.7		
CD Electricity Use (kWh/100mi)				29.0	35.4									
CD Electricity Use (GGE/100mi)				0.9										
CD Gasoline Use (GGE/100mi)				0.2										
PHEV CD Range (miles)				11.0										
Charges per Day				1.0										
Days per Week Driven				5										
Share of CD miles				24%										
Purchase Price (Per Vehicle)	$ 19,000	$ 23,000	$ 25,000	$ 32,000	$ 35,000			$ 23,000	$ 23,000	$ 19,000	$ 25,000	$ 26,000		
Incentive (Per Vehicle)	$ -	$ -	$ -	$ -	$ -			$ -	$ -	$ -	$ -	$ -		
Maintenance & Repair (Per M	$ 0.18	$ 0.18	$ 0.18	$ 0.17	$ 0.17			$ -	$ 0.18	$ 0.18	$ 0.18	$ 0.18		
Heavy Duty Vehicle Info														
Vehicle Type	Single Unit Short-Haul Truck													
Number of HDVs	0	0			0	0	0	0	0	0	0	0	0	0
Annual Mileage	16,500	16,500			0	16,500	16,500	16,500	16,500	16,500	16,500	16,500	16,500	16,500
Fuel Economy (MPGGE)	5.3	6.3			0.0	41.0	8.1	0.0	6.3	6.3	5.3	0.0	5.4	5.4
Fuel Consumption (GGE/100m	19.0	15.9			0.0	2.4	12.3	0.0	15.9	15.9	19.0	0.0	18.7	18.7
Fuel Consumption (DGE/100m	16.9	14.1			0.0	2.2	10.9	0.0	14.1	14.1	16.9	0.0	16.6	16.6
CD Electricity Use (kWh/100mi)					0.0									
Share of LNG Fuel Use (Energy %)														0%
DEF Use (% of fuel consumpt	0%	3%			0%	0%	3%	3%	3%	3%	0%	0%	0%	0%
Purchase Price (Per Vehicle)	$ -	$ 75,000			$ -	$ -	$ 115,000	$ 135,000	$ 75,000	$ 75,000	$ -	$ -	$ 130,000	$ 130,000
Incentive (Per Vehicle)	$ -	$ -			$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Maintenance & Repair (Per M	$ 0.20	$ 0.20			$ -	$ 0.20	$ 0.20	$ 0.20	$ 0.20	$ 0.20	$ 0.20	$ 0.20	$ 0.20	$ 0.20

For details, contact aburnham@anl.gov

Hybrid Work Truck Payback Calculator

Hybrid Work Truck Payback Worksheet

Conventional Vehicle Usage Profile:

Average vehicle use per year (Days)	235	
Projected vehicle life (Years)	13.5	(Maximum 15 years)
Average Hours of vehicle use per day	8.1	

Operating Profile:		
	Hours per day -- Stop / Go	2.3
	Hours per day -- Open highway	0.1
	Hours per day -- Idle time	4.7
	Hours per day -- Shutdown	1

Stop & Go Driving Profile: (Select one) (Place an "X" in appropriate block)		
		High frequency stop and go driving 15+ cycles / hour)
	x	Medium frequency stop and go driving conditions (8-14 cycles / hr.)
		Low frequency stop and go driving conditions (7 or fewer cycles per hour)

Fuel Consumption Data -- Current Application

Average gallons of fuel consumed per hour -- In Transit	2
Average gallons of fuel consumed per hour -- Idling	1.8
Average gallons of aux engine fuel consumed per hour	0.5
Average cost of fuel (per gallon)	5.15

Hybrid Projected Operating Cost Reductions:

Idle reduction:	4.3	Hours per day (average)
Auxiliary engine use reduction	2	Hours per day (average)

Hybrid Work Truck Payback Calculator

Hybrid Work Truck Payback Worksheet

Hybrid Projected Maintenance Cost Differential:

Brakes -- Current application demand cost per year	250		
Engine -- Current application demand cost per year	2000		
Auxiliary engine savings / year (reduced use or elimination)	500		
Hybrid energy storage system maintenance cost (battery replacement, accumulator rebuild, etc.)	1000	in year	8

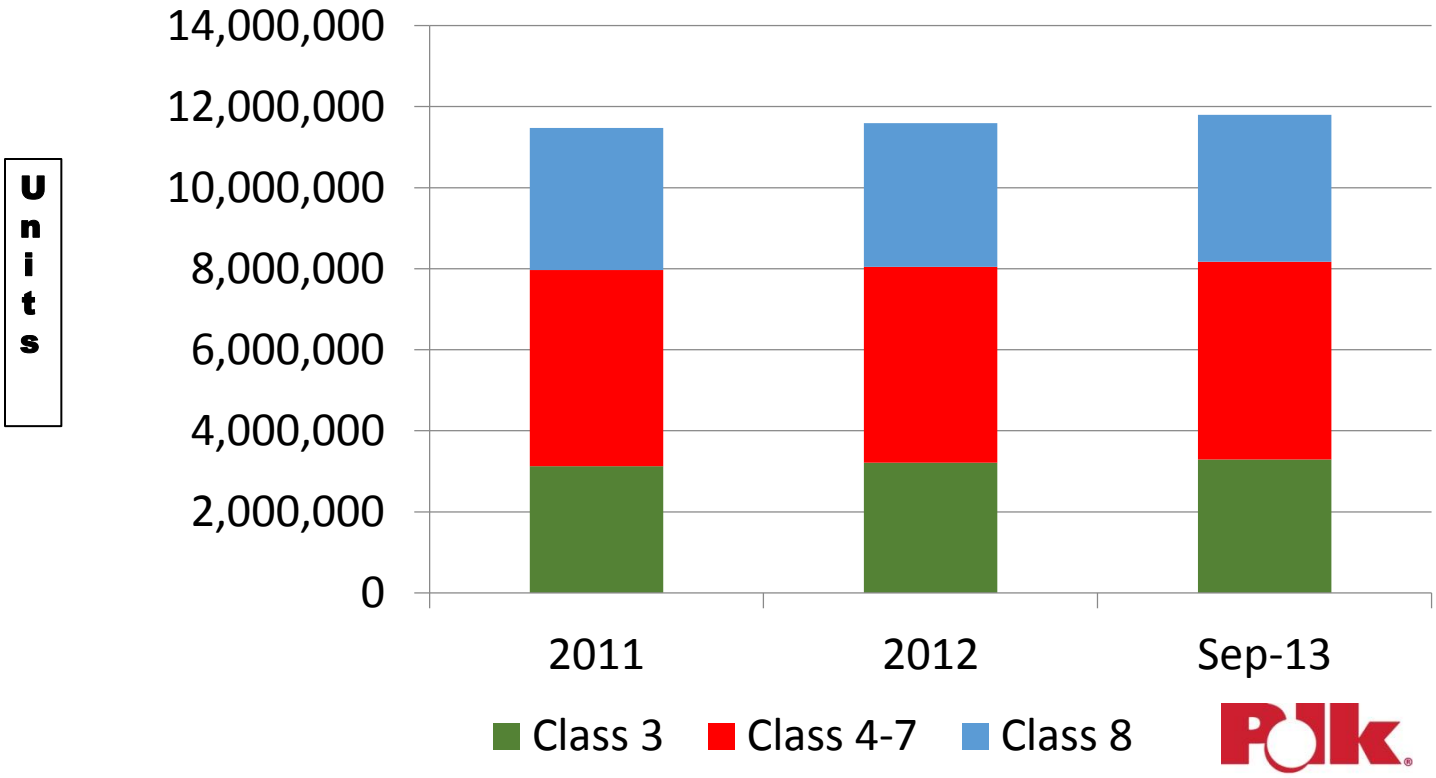
Projected Hybridization Cash Flows per year

Year	Transit Fuel Savings		Idle Fuel Savings		Aux Fuel Savings		Maintenance Cost Differential			Hybrid	Total $ by
	Gallons	$	Gallons	$	Gallons	$	Brakes	Engine	Auxiliary	Maint.	Year
1	432	2,227	1,011	5,204	235	1,210	180	1,211	500		10,532
2	432	2,227	1,011	5,204	235	1,210	180	1,211	500		10,532
3	432	2,227	1,011	5,204	235	1,210	180	1,211	500		10,532
4	432	2,227	1,011	5,204	235	1,210	180	1,211	500		10,532
5	432	2,227	1,011	5,204	235	1,210	180	1,211	500		10,532
6	432	2,227	1,011	5,204	235	1,210	180	1,211	500		10,532
7	432	2,227	1,011	5,204	235	1,210	180	1,211	500		10,532
8	432	2,227	1,011	5,204	235	1,210	180	1,211	500	-1,000	9,532
9	432	2,227	1,011	5,204	235	1,210	180	1,211	500		10,532
10	432	2,227	1,011	5,204	235	1,210	180	1,211	500		10,532
11	432	2,227	1,011	5,204	235	1,210	180	1,211	500		10,532
12	432	2,227	1,011	5,204	235	1,210	180	1,211	500		10,532
13	432	2,227	1,011	5,204	235	1,210	180	1,211	500		10,532
14	432	2,227	1,011	5,204	235	1,210	180	1,211	500		10,532
Total Fuel	6,054		14,147		3,290						
Total Dollars		31,176		72,857		16,944	2,516	16,958	7,000	-1,000	146,450

Net present value of total life cycle savings at 5.2% **rate of return:** $102,592.04

Commercial Vehicles In Use Class 3-8 U.S.

(January 2011-September 2013)

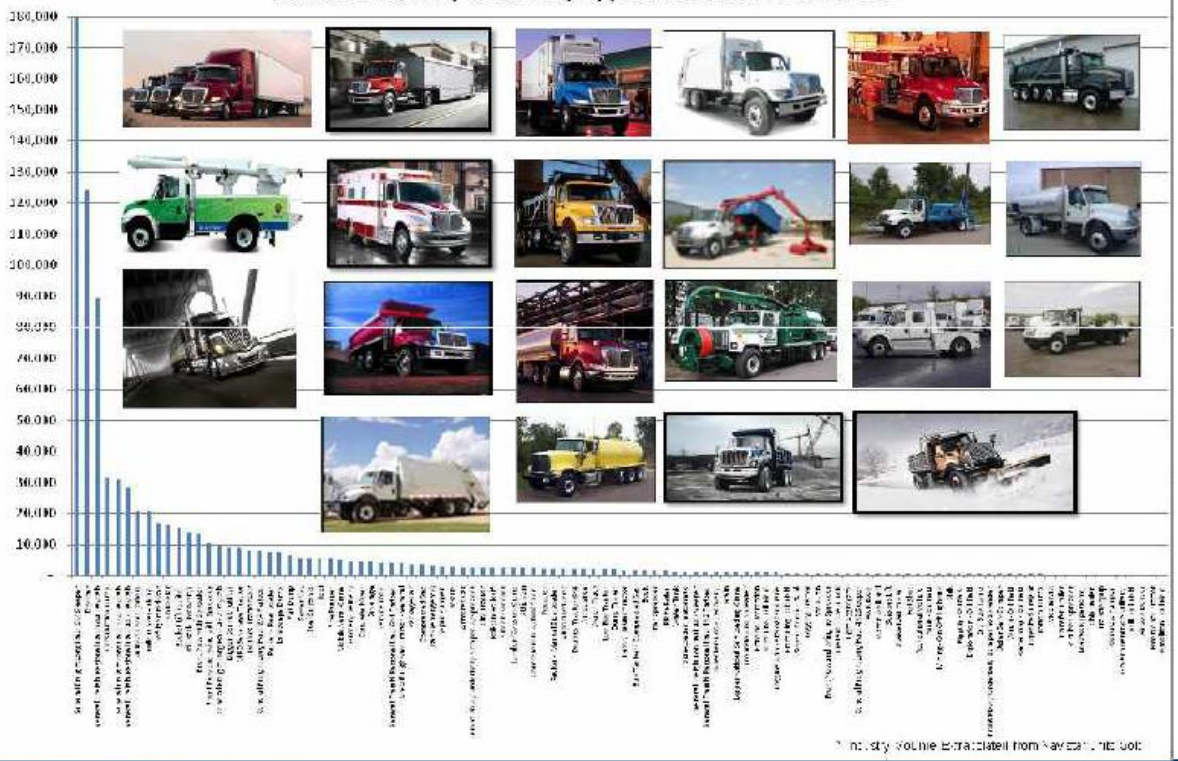


Work Trucks Come in All Shapes and Types

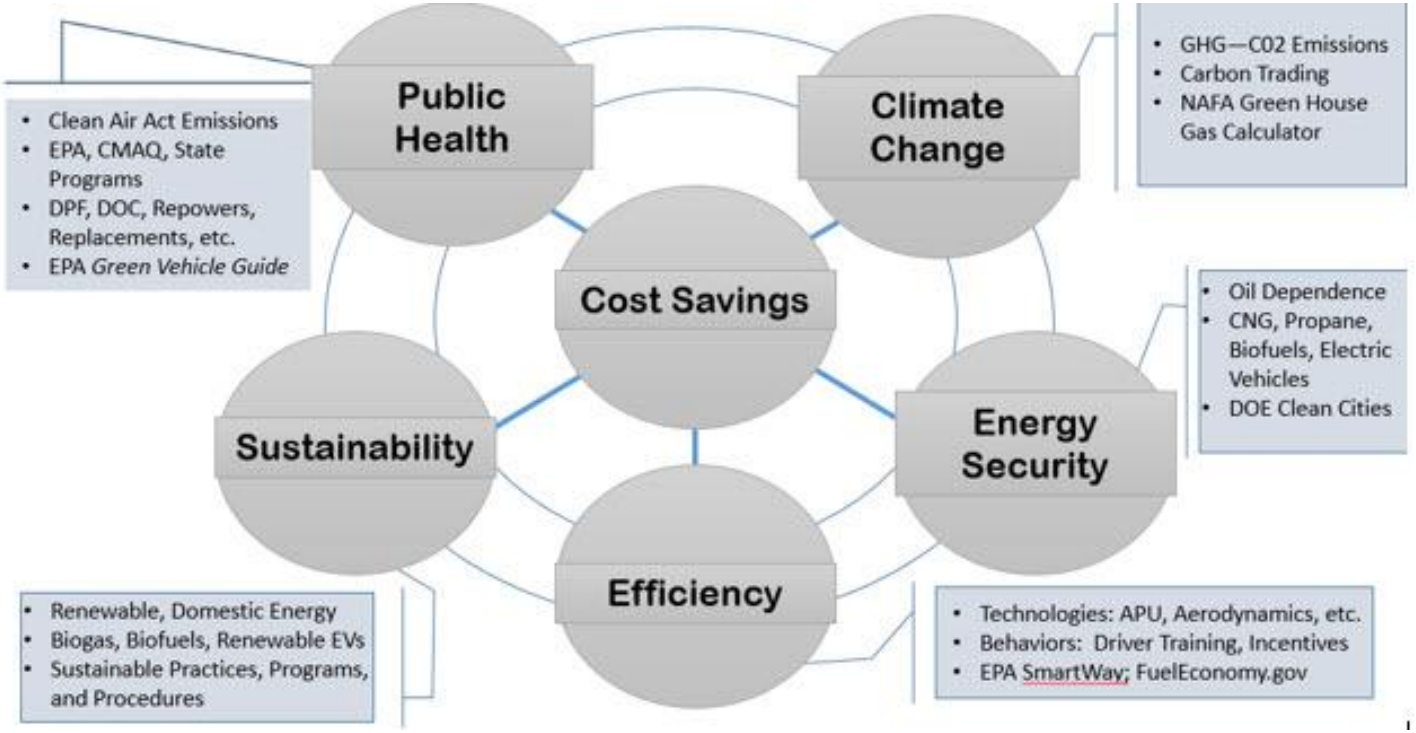
Many Applications

NAVISTAR® TRUCK GROUP

Estimated Industry Volume by Application for FY2006-FY2008



Where should a fleet begin?



Source: CleanFuelsOhio

Thank you!

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